HONORS THESIS ABSTRACT

THESIS SUBMISSION FORM

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THESIS TITLE: Impact of Omega-3 Fatty Acids on Heart Disease

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ADVISOR'S DEPARTMENT: Biology

DISCIPLINE: Biology

YEAR: Spring 2013

PAGE LENGTH: 16

BIBLIOGRAPHY: pg. 15-16

ILLUSTRATED:

PUBLISHED (YES OR NO):

LIST PUBLICATION: pg. 4,5, 6, 8,9,10, 13,14

COPIES AVAILABLE (HARD COPY, MICROFILM, DISKETTE):

ABSTRACT (100-200 WORDS):

Northern Illinois University

Impact of Omega-3 Fatty Acids on Heart Disease

A Thesis Submitted to the

University Honors Program

In Partial Fulfillment of the

Requirements of the Baccalaureate Degree

Department of Biology

By

Erin Ortiz

Dekalb, IL

Spring 2013

University Honors Program

Capstone Approval Page

Capstone Title (print or type)

Impact of Omega 3- Fatty Acids on Heart Disease.

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Date of Approval (print or type) February 1, 2013 MAY 9, 2013

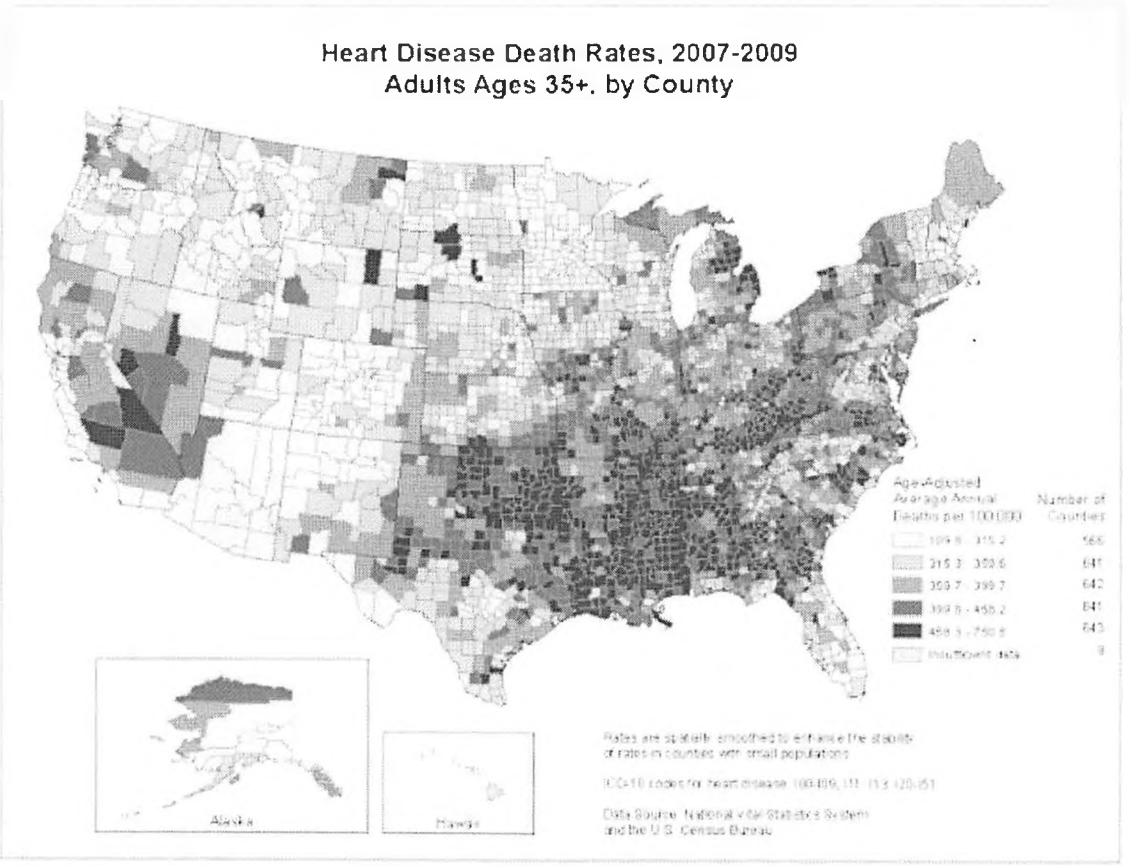
Honors Thesis Abstract

Heart Disease is the leading cause of death in America. Research has shown that people who consume at least 2-3 portions of Omega-3 fatty acids a week can reduce the risk of heart disease by up to 29%. Many studies have been performed all over the world to support this evidence. Certain foods containing Omega-3 fatty acids have also been linked a reduction in heart disease, such as fish and green vegetables. For this thesis, I will be looking at previous studies on the benefits of Omega-3 fatty acids and conducting my own survey on local resident's knowledge of Omega-3 fatty acids.

Background Research

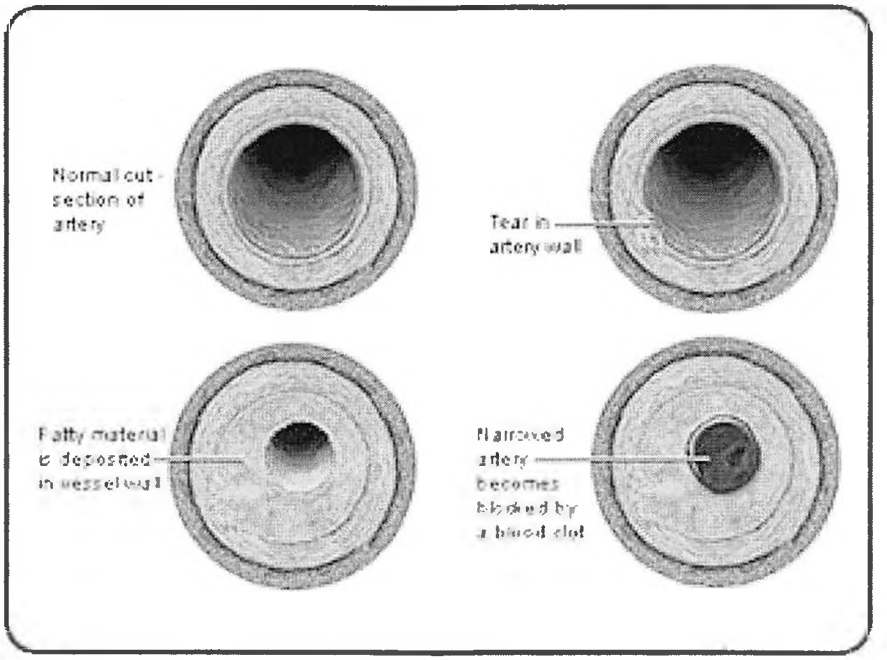
For many years, heart disease has been the leading cause of death in the United States. According to the Center for Disease Control, twenty-five percent of all deaths in American have been attributed to heart disease. This costs the United States over $100 billion dollars every year. Consequences of the American diet and lack of exercise, have led to an increases in high blood pressure and high LDL cholesterol which increases the chances of developing heart disease. Heart disease death rates vary throughout the United States (Figure 1). The highest numbers of heart disease occur in the southeastern United States. The upper Midwest and states in the Rocky Mountain region have the lowest numbers of heart disease related deaths.

Figure 1. Heart Disease Death Rates for Adults 35 and Over. (Center for Disease Control)



Atherosclerosis is the result of cholesterol buildup in the artery and blood vessel walls. The excessive buildup of plaque causes vasoconstriction of the arteries and prevents blood from flowing to the heart (Figure 2). This event decreases the amount of oxygen entering the heart, causing the heart muscles to weaken over time (Center for Disease Control). Weakening of the heart creates a decline in the electrical conductivity of the heart, leading to arrhythmias or abnormal heart beat. As a result of the plethora of heart disease cases in America, many doctors and health professionals have been turning to alternative medicines, such as omega-3 fatty acids to help combat this disease. Over the past few years the public's interest in omega-3 fatty acids has increased, with the news that it can help combat heart disease.

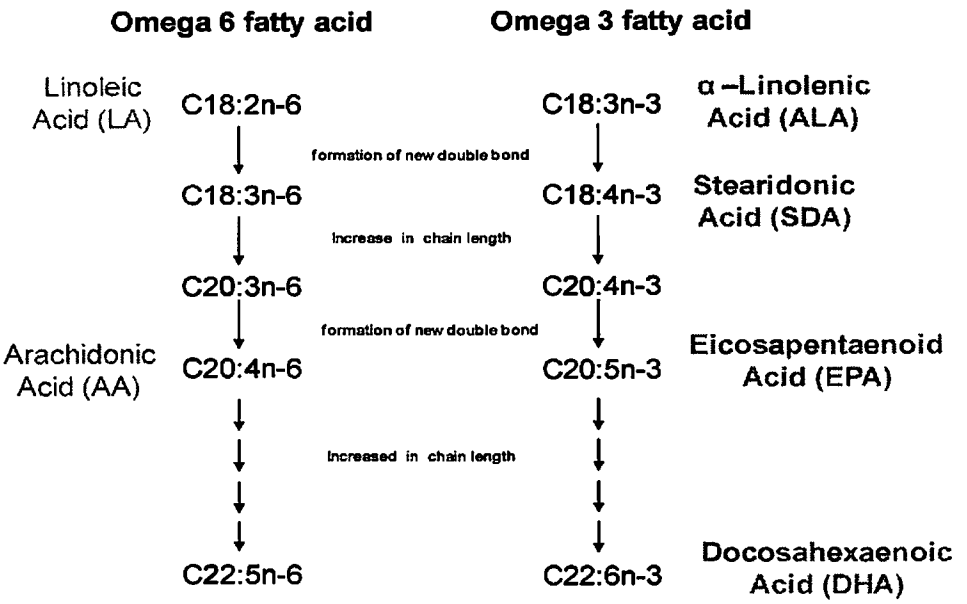
Figure 2. Atherosclerosis. Centers for Disease Control.



Doctors have been very interested in the structure of this fatty acid. Omega fatty acids are composed of a hydrocarbon chains that are attached to a hydrophilic carboxyl group and hydrophobic methyl group (Harper and Jacobson, 2002). The omega end is attached to the methyl end. The differences in fatty acids are determined by the location of the carbon bonding

sites (Harper and Jacobson, 2002). Omega- 3 fatty acids have their double bonds located on the third carbon. The bonding properties of Omega-3 allow it to elongate and desaturate forming the cardioprotective effects. (Harper and Jacobson, 2002)

Figure 3. Omega Fatty Acid Structure. (University of Illinois Extension)



http://www.extension.org/pages/63900/omega-3s-and-omega-6s-a-basic-scientific-view

As knowledge of the structure of omega-3 surfaced, scientists and medical providers were able to incorporate these new findings into their research. Hugh Sinclair was the first to recognize the importance of omega-3 fatty acids (Nettleton, 1995). He recognized that these fatty acids were essential in our diets and concluded that deficiencies would develop if we did not consume omega-3 fatty acids (Nettleton, 1995). In 1966, the American Heart Association released a report on the benefits of eating omega-3 fatty acids (Cancer. org).

During the 1970s, Danish researchers Bang and Dyerberg, investigated the link between omega-3 fatty acids and heart disease in Greenland. They were interested in the low presence of

coronary heart disease in the Inuits of Greenland even though they ate diets rich in fat (Din, Newby, and Flapan, 2004). The Danish researchers hypothesized that the Inuit's diet of fish, seal, and whale could be contributing to the low prevalence of heart disease (Din et al., 2004). These diets contained less saturated fat and high amounts of monounsaturated and polyunsaturated fats. The Inuits of Greenland had only a 5.3 % rate of heart disease compared to 34.7% in Denmark and 40.4% in American (Nettleton, 1995). Bang and Dyerberg's study set the foundation for further research and studies to be conducted looking at the benefits of consuming omega-3 fatty acids.

Other countries diets have also been the interest of studies. In Crete, they consume high quantities of fruits, vegetables, and olive oil. The Lyon Diet Heart Study examined the effects the Crete Mediterranean diet had on lowering cardiovascular death and nonfatal MI (Harper and Jacobson, 2003). Six-hundred and five previous MI patients were asked to begin incorporating the Crete Mediterranean diet into their eating routine. After two years the study showed that there was a 76% risk reduction in cardiovascular death and nonfatal MI (Harper and Jacobson, 2003).

The first clinical cardiovascular study on omega-3 fatty acids was the Diet and Reinfarction Trial (DART), performed in 1989. Medical professionals had 1,015 men eat two servings of fatty fish per week, while another 1,018 men were instructed to not eat fish. The men advised to eat fish were asked to consume 200-400 grams twice a week. After two years, the men in the fish eating group had a 29 percent decrease in all-cause mortality (Covington, 2004). Men in both groups still experienced myocardial infarctions, but less men from the fish eating group died from a heart attack (Leaf , Kang, Xiao, and Billman,. 2003). These men were

followed for over 15 years and overall the fish group had a decrease in all-cause mortality and coronary heart disease (Figure 3).

Figure 3. DART Mortality rates in men 1983-2000

Table 2 Mortality from coronary disease, stroke and all causes in men who received advice to eat more fish compared with those who did not in the Diet and Reinfarction Trial (DART) 1983–2000

Hazard by follow-up period in years	Number of deaths advice/no advice	Hazard (CI)	
		Crude hazard	Adjusted hazard[a]
All-cause mortality			
0–2	94/131	0.70 (0.54, 0.92)	0.73 (0.56, 0.95)
2–5	130/97	1.31 (1.01, 1.70)	1.31 (1.01, 1.71)
5–10	163/159	1.02 (0.82, 1.27)	1.02 (0.82, 1.27)
10+	143/166	0.84 (0.68, 1.06)	0.85 (0.68, 1.07)
Overall	530/553	0.94 (0.84, 1.06)	0.95 (0.85, 1.07)
Coronary heart disease			
0–2	78/117	0.65 (0.49, 0.87)	0.68 (0.51, 0.91)
2–5	83/75	1.08 (0.79, 1.47)	1.08 (0.79, 1.48)
5–10	107/104	1.03 (0.78, 1.35)	1.04 (0.79, 1.36)
10+	86/88	0.96 (0.71, 1.29)	0.98 (0.72, 1.32)
Overall	354/384	0.91 (0.79, 1.05)	0.92 (0.80, 1.07)
Stroke			
0–2	5/2	—	—
2–5	2/0	—	—
5–10	12/7	1.71 (0.67, 4.34)	1.57 (0.61, 4.03)
10+	10/14	0.70 (0.31, 1.57)	0.71 (0.32, 1.61)
Overall	29/23	1.24 (0.72, 2.15)	1.23 (0.71, 2.14)

[a]Adjusted for history of myocardial infarction, angina, hypertension at baseline; X-ray evidence of cardiomegaly, pulmonary congestion or pulmonary oedema at baseline; and treatment (at entry) with β-blockers, other anti-hypertensives, digoxin/anti-arrhythmics, or anticoagulants.

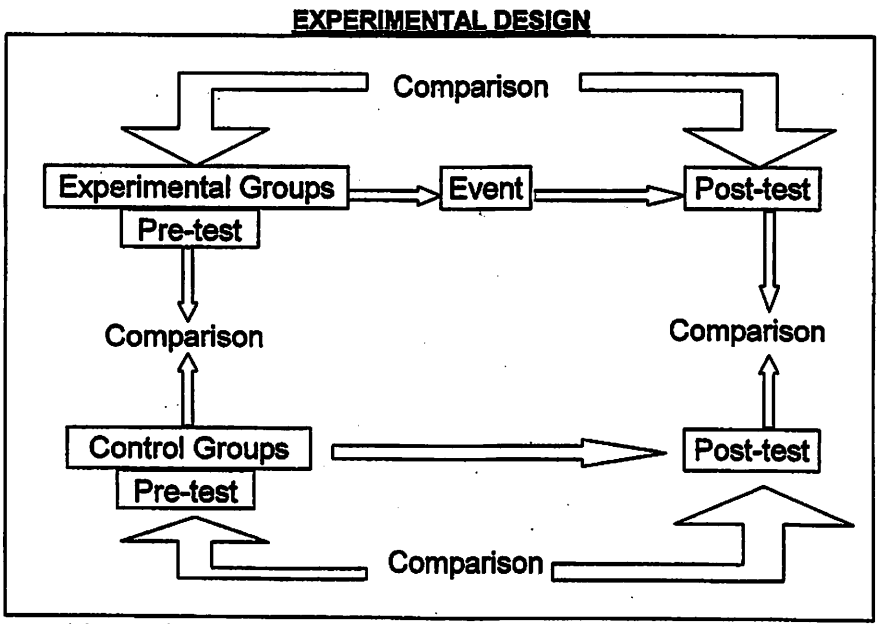
The largest study performed on omega-3 fatty acids was the GISSI- Prevenzione trial. Researchers analyzed the results of over 11,000 participants, who had coronary heart disease. They were divided into four groups and received either 300 mg of Vitamin E, 850 mg of Omega-3 fatty acids, both, or neither (Covington, 2004). The study followed the participants for three and one –half years. The results showed that the omega-3 group had a 45 percent decrease in sudden death and a 20 percent decrease in all-cause mortality (Covington, 2004).

A study in Italy examined 40 patients with dual-chamber pacemakers, who had been diagnosed with paroxysmal atrial tachyarrhythmia (Reiffel and McDonald, 2006). Atrial tachyarrhythmia is an abnormal fast heartbeat, if not treated it can lead to a serious condition called atrial fibrillation (CDC.gov). During a four month period the doctors had the patients

take 1 gram of omega-3 fatty acid. The patients saw a 59 percent decrease in the number of atrial tachyarrhythmia episodes. The doctors then advised the patients to discontinue taking the omega-3 supplements and after 4 month patients can in for a follow-up session. At the follow up, doctors found that the patients were all back to pretreatment levels for number of tachyarrhythmia episodes and burden of duration (Reiffel and McDonald, 2005).

As the research on Omega-3 fatty acids advances may studies have tried to disprove its positive health benefits. However, these studies should be disregarded based on their experimental design (Reiffel and McDonald, 2006). These studies had a small number of participants and had disparities in the methods of distribution of omega-3, including duration of supplementation control of background diet, and controlling intake of other fatty acids (Reiffel and McDonald, 2006). True experimental design follows the scientific method (Figure 4)

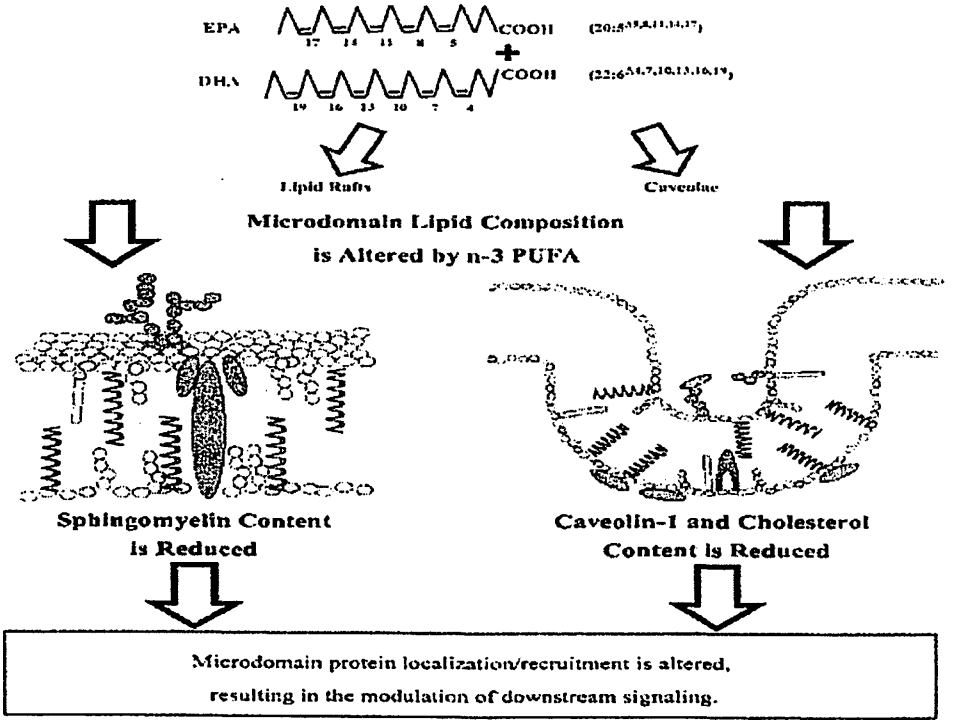
Figure 4. Experimental Design. http://www.fwr.org/wrcsa/1202103.htm



Omega-3 fatty acids can be broken down into three division's eicasapentaenoic acid (EPA) and docosahexaenoic acid (DHA); these can be found in fatty fish. The last group is alpha-linolenic

acid (ALA), can be found in seeds, oils, green leafy vegetables, and nuts (Covington, 2004). Omega-3 fatty acids have been shown to reduce high cholesterol and high blood pressure. In addition, it can lower triglycerides and abnormal heart rhythm (Ehrlich, 2011). EPA and DHA are found in the plasma membrane of cell. Studies have shown that EPA attaches to the cholesteryl esters and is found in higher concentrations in the cell membrane. DHA is absorbed by the plasma lipids (Nettleton, 1995).

In addition, DHA is important for the development of the nervous system and visual abilities in babies during the first few months of life (Ehrlich, 2011). Omega- 3 fatty acids are an important part of the cells membrane, this fatty acid signals hormones that help with blood clotting, relaxation and contractions of artery walls, along with inflammation (Harvard, 2012). Below is a picture that demonstrates how EPA and DHA interacted with the cell membrane. When these two compounds bind to the cell membrane they alter the chemical function and binding process of proteins (Harris, 2008).



Mothers, who do not consume enough omega-3 fatty acids during pregnancy, can be putting their children at risk for developing poor vision and nerve problems (Ehrlich, 2011). The human body cannot manufacture omega-3 fatty acids; as a result we must consume them through the foods we eat.

There are many natural sources of food that contain omega-3 fatty acids. The most common source of these fatty acids can be found in fish. Salmon, Tuna, and Halibut just to name a few of the fish that contain omega-3 fatty acids. There are some risks associated with eating high levels of fish. Methylmercury can be found in some sources of fish. Low levels of mercury can be found in tuna and salmon. Women, who are pregnant or looking to become pregnant, should avoid fish that are linked to high levels of mercury (Cancer.org).

Other natural sources of omega-3 fatty acids are found in leafy green vegetables (spinach), grains (pasta, oatmeal), oils (flaxseed oil, cod-liver oil,) peanut butter, walnuts, eggs, and pumpkin seeds (Johnson, 2012). The American Heart Association has put out guidelines for omega-3 consumption rates. The list below from the University of Maryland Medical Center has the omega- 3recommendations for adults.

- For healthy adults with no history of heart disease: The American Heart Association (AHA) recommends eating fish at least 2 times per week.
- For adults with coronary heart disease: The AHA recommends an omega-3 fatty acid supplement (as fish oils), 1 gram daily of EPA and DHA. It may take 2 - 3 weeks for benefits of fish oil supplements to be seen. Supplements should be taken under the direction of a physician.
- For adults with high cholesterol levels: The AHA recommends an omega-3 fatty acid supplement (as fish oils), 2 - 4 grams daily of EPA and DHA. It may take 2 - 3 weeks for benefits of fish oil supplements to be seen. Supplements should be taken under the direction of a physician.
- For adults with high blood pressure, scientists generally recommend 3 - 4 grams per day, but you should only take under the supervision of a health care provider.

Artificial sources of omega-e fatty acids can be found in fish oil supplements, including Omacor a prescription that have high concentrations of EPA and DHA. Studies have shown that Omacor can reduce triglycerides by up to 45 percent (University of Rochester.edu). The dosage amount for fish oil tablets should be based on the amount of EPA and DHA, not fish oil total. The most common amounts of DHA and EPA in fish tablets are 0.12 grams DHA and 0.18 grams EPA (Ehrlich, 2011). However, adults should not consume more than 3 grams of omega-3 fatty acids from supplements without consulting a doctor; there is risk of increased bleeding (Ehrlich, 2011). Excessive intake of fish oils can cause gas, bloating, belching, and diarrhea (Ehrlich, 2011).

Potential interactions with other medications can occur, so it is important to consult a doctor before starting any omega-3 regiment. High doses of omega-3 fatty acids can cause excessive bleeding in patients who are taking blood thinning medications, such as Coumadin or Plavix (Ehrlich, 2011). In addition, people on diabetes medications may see a spike in blood sugar levels (Ehrlich, 2011).

Omega- 3 fatty acids have been shown to play a large role in reducing the risk of heart disease and preventing it from reoccurring. More studies are being conducted to see if these fatty acids can help with other human ailments. Now, research is being done on effects of Omega-3 on arthritis, diabetes, and cancer to name a few. The future of Omega-3 research may lie in nutrigenomics; this new field looks at the link between diet, health, and genomics. With continued exploration scientists in this field hope to understand how nutrition influences our metabolic pathways and homeostatic controls (Afman and Muller, 2006).

Omega-3 Recipes

Roast Side of Salmon with Mustard, Tarragon, and Chive Sauce

Ingredients

- 2/3 cup mayonnaise
- 1/2 cup spicy brown mustard (such as Gulden's)
- 6 tablespoons chopped fresh tarragon
- 6 tablespoons chopped fresh chives
- 2 tablespoons (packed) golden brown sugar
- 2 tablespoons fresh lemon juice
- 2 teaspoons finely grated lemon peel
- 1 3 1/2- to 3 3/4-pound whole side of salmon with skin (about 1 1/2 inches thick at thickest part)

Preparation

- Position rack in center of oven and preheat to 450°F. Line large rimmed baking sheet with parchment paper. Mix first 7 ingredients in medium bowl. Season mustard sauce lightly with salt and generously with pepper. Place salmon, skin side down, on diagonal on prepared sheet. Spoon 1/2 cup mustard sauce atop salmon, then spread over, covering completely. Sprinkle salmon generously with salt and pepper. Roast just until salmon is opaque in center, about 15 minutes. Using parchment as aid, transfer salmon to platter. Cut crosswise into pieces and serve with remaining mustard sauce.

- Nutritional Information

One serving contains the following:
Calories (kcal) 473.48
%Calories from Fat 55.4
Fat (g) 29.13
Saturated Fat (g) 4.22
Cholesterol (mg) 132.06
Carbohydrates (g) 4.36
Dietary Fiber (g) 0.07
Total Sugars (g) 3.46
Net Carbs (g) 4.29
Protein (g) 45.26

Read More http://www.bonappetit.com/recipes/quick-recipes/2008/12/roast_side_of_salmon_with_mustard_tarragon_and_chive_sauce#ixzz2K9XQ5v4b

Chicken, Asparagus, and Broccoli Stir-Fry

Ingredients

- 2 tablespoons Asian sesame oil, divided
- 2 garlic cloves, chopped
- 2 cups 1 1/2-inch pieces asparagus
- 2 cups small broccoli florets
- 6 tablespoons low-salt chicken broth, divided
- 1 1/4 pounds tablespoons skinless boneless chicken breast halves, thinly sliced crosswise
- 4 large green onions, chopped
- 3 tablespoons tablespoons hoisin sauce*
- 1 tablespoon oyster sauce

Preparation

- Heat 1 tablespoon oil in large nonstick skillet over medium-high heat. Add garlic and stir 30 seconds. Add asparagus, broccoli, and 4 tablespoons broth. Cover and cook until vegetables are crisp-tender, about 3 minutes. Transfer vegetables to bowl.
- Add remaining 1 tablespoon oil to skillet. Sprinkle chicken with salt and pepper; add chicken and green onions to skillet. Stir-fry until chicken is just cooked through, about 3 minutes. Mix in hoisin sauce, oyster sauce, vegetables, and remaining 2 tablespoons broth. Toss until heated through and sauce coats evenly, about 1 minute. Season to taste with salt and pepper. Transfer to bowl.
- *Available in the Asian foods section of many supermarkets and at Asian markets.

Read More http://www.bonappetit.com/recipes/2006/03/chicken_asparagus_and_broccoli_stir-fry#ixzz2K9XxzJU7

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Sample Survey

Survey

1. Gender ☐ Male ☐ Female
2. Age _____
3. Educational level

   ☐ High School

   ☐ Associate degree – in college

   ☐ Bachelor's degree

   ☐ Master's degree

   ☐ PhD

4. Please state your occupation _____
5. Which of the following is not a health benefit of Omega-3 fatty acids? (circle)

   a. Protects against irregular heartbeats b. Lowers blood pressure.

   c. Lowers LDL cholesterol d. Prevents blood clots

6. Which of the following is NOT an advantage of consuming excess omega-3 fatty acids?

   a. Increase bleeding time c. Interfere with wound healing

   b. Raise LDL d. Improves immune function.

7. Do you eat foods that contain omega-3 fatty acids?

   ☐Yes ☐No

8. If yes, please state. _____

   _____

9. What do you know about omega-3 fatty acid and relation to heart disease?

_____

_____

_____

10. Do you currently have a heart disease?

☐Yes ☐No

11. If yes, please state. _____

12. Does your family have any history of Heart Disease?

☐Yes ☐No

13. If yes, select from the following: (check all that applies)

☐ Mother ☐ Father ☐ Brother ☐ Sister

☐ Aunt ☐ Uncle ☐ Grandparent

14. Did you eat any of the following foods during the past week? (You may select more than one). Circle how often you eat this food **per week.**

a. Salmon	(1)	(2)	(3)	(>3)
b. Flaxseed	(1)	(2)	(3)	(>3)
c. Mackerel	(1)	(2)	(3)	(>3)
d. Wild Rice	(1)	(2)	(3)	(>3)
e. Walnuts	(1)	(2)	(3)	(>3)
f. Canola Oil	(1)	(2)	(3)	(>3)
g. Beans (Black or Kidney)	(1)	(2)	(3)	(>3)
h. Other _____	(1)	(2)	(3)	(>3)

15. Do you currently take omega-3 fatty acids?

☐ Yes ☐No

14. If yes, why?

_____

Survey Results

Number	Gender	Age	Education	Occupation	Health Benefits	Disadvantages	Foods (State)	Knowledge	Current Health
1	F	21	College	Student	100	0	Y	Reduce risk of heart disease	No
2	F	25	Bachelors' s Degree	Unversity Service Assistant II	100	0	Y, salmon, nuts, flaxseed, beans	prevent risk of heart disease, lists sources	no
3	Male	59	High School	Pressman	100	100	No	Nothing	no
4	Female	77	High School	Housewife	0	100	No	No	Yes
5	Male	83	High School	Retired	0	100	No	N/A	Yes, Heart Bypass
6	Female	48	Bachelors' s Degree	Supervisor	100	100	Yes, Fish	Increase LDL	No
7	Male	51	Bachelors' s Degree	Agricultural Inspector	100	0	Yes	Reduce risk of heart disease	Yes, 4 stents placed
9	Female	38	High School	Nutrition and Culinary Director	0	0	Yes	Reduce risk of heart disease	no
12	Male	69	High School	Retired	100	0	Yes (fish oysters)	Lowers chance of heart disease	no
13	Female	67	High School	Retired	100	0	Yes (seafood)	Lowers chance of heart disease	no

14	Female		21	High School	student/tutor	0	0	no	main source in fish	no
15	Female		43	Associates degree	office support specialist	100	100	yes (salmon, tuna	will help you	no
16	Female	40+		Master's degree	Assoicate Director for ACCESS	100	100	Yes (salmon, and most fish)	food for heart and eyes	no
17	Female		21	Bachelors' s Degree	student	100	0	no	omega-3 acids are important for health functions, decrease risk of heart disease	no
18	Female		19	High School	student	0	0	yes, beans	no	no
19	Female		29	Master's degree	grad student	0	0	yes, fish	reduces cholesterol	no
20	Female		20	High School	student	0	0	yes, fish	prevent heart disease	no
21	Male		21	Associates degree	student	100	0	yes, salmon, mixed nuts	good for you	no

The Surveys showed that the majority of particpants had some knowledge of omega-3 fatty acids. Most of the partipipants incorporate Omega-
Everyone knew that Omega-3 fatty acids help reduce the risk for heart disease. Few people knew that Omega-3 fatty acids can help with other l

Family	Foods Eaten	Supplements
No	Salmon, Walnuts, canola oil, beans	Yes, reduce risk of disease
Yes, Grandpa, uncle	Salmon, Wild Rice, Walnuts	No
Yes, father, uncle	Flaxseed, Wild Rice, Walnuts, Canola Oil, Beans	No
N/A	N/A	no
Yes, Father	Flaxseed, Canola Oil	No
Yes, Father	Beans	No
Yes, Father	Wild Rice, Walnuts, Canola Oil, Beans	No
Yes, Grandfather	Canola Oil, Beans	No
no	Canola oil, beans	no
no	wild rice,canola oil, beans, clams	no

no	flaxseed, walnuts, beans	no
yes (father, grandparent)	canola oil, beans	sometimes
no	salmon, flaxseed, wild rice, walnuts, beans	yes, recommended by doctor
no	none	no
no	black beans	no
no	salmon, canola oil, beans	no
no	Salmon, Walnuts,	no
no	salmon	no

3 fatty acids into their diets.
ɔody functions.